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AMENDMENT

IN THE CLAIMS

Please amend the claims as indicated in Appendix A submitted herewith according to the revision to 37 C.F.R. § 1.121 concerning a manner for making claim amendments.

REMARKS

Claims 1-21 are presently pending in the captioned application.

Pursuant to the enclosed amendment, claims 1 and 8 are currently amended and claims 3 and 4 cancelled and claims 9-21 withdrawn by the Examiner.

Claim 1 has been amended to delete "phosphorous", "boron" and "sulfur" from the definition of E¹ and to delete "iron" from the definition of E². Correspondingly, claim 8 has been amended to delete catalysts containing sulfur. No new matter has been added by the any of the amendments.

Accordingly, Applicants respectfully request the Examiner to enter the amendments, reconsider and withdraw the rejections in view of the arguments and allow all claims pending in the application.

1. Rejection of Claims 1-2 and 5-7
under 35 U.S.C. § 102(b)

The Office Action rejects claims 1-2 and 5-7 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,370,259 ("Eastman et al."). The Office Action states:

Eastman discloses a process of oxidative dehydrogenation of ethane to ethylene in the presence of a catalyst containing mixed oxides of Mn, P, and Na with an atomic ratio of 1:0.3 to 0.25:0.10 to 0.30 and a support (the abstract; col. 2, lines 7-41).

Eastman discloses the condition of temperature and SV on column 3, lines 36-51.

Eastman discloses the catalyst is dried less than 300 degrees Celsius on column 4, line 20.

Applicants respectfully traverse the rejection over Eastman et al. because each and every claimed limitation is not taught. In particular, Eastman et al. requires the presence of phosphorous, which is no longer claimed by independent claim 1. Applicants remind the Examiner that the Federal Circuit has made clear that a negative pregnant is not enough to show anticipation. Rowe v. Dror, 112 F.3d 473, 42 USPQ2d 1550 (Fed. Cir. 1997). Thus, where a reference does not explicitly describe anything inconsistent with a claimed invention, if that reference nevertheless fails to make an affirmative suggestion of the claimed limitations, that reference cannot anticipate the claimed invention. Id. Since nothing is

disclosed with respect to a catalyst without phosphorous, Eastman et al. does not anticipate claims 1-2 and 5-7.

Turning to the rule, the Federal Circuit has spoken clearly and at some length on the question of anticipation. Anticipation requires that each and every element of the claimed invention be disclosed in a single prior art reference. Verdegaal Bros. v. Union Oil Co. of California, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Those elements must be expressly disclosed as in the claim. In re Bond, 15 USPQ2d 1566 (Fed. Cir. 1990).

The prior art reference must also be enabling, thereby placing the allegedly disclosed matter in the possession of the public. In re Brown, 329 F.2d 1006, 1011, 241 USPQ 245, 249 (C.C.P.A. 1964). In order to accomplish this, the reference must be so particular and definite that from it alone, without experiment or the exertion of his own inventive skill, any person versed in the art to which it pertains could construct and use it. Id. at 250.

In the present application, independent claim 1 recites a multimetal mixed oxide having the formula



where Mn denotes manganese;

O denotes oxygen; and

E¹ represents one or more metal elements selected from the group consisting of arsenic, antimony, selenium,

tellurium, fluorine, chlorine, bromine, iodine, niobium, tantalum, tungsten, rhenium and copper.

Notably, phosphorous has been deleted from the recitation of E¹.

The catalysts of Eastman et al. are Mn-P-alkali metal-type catalysts. In particular, Eastman et al. specifically teaches a method of oxidatively dehydrogenating hydrocarbons in the presence of a catalyst consisting essentially of a mixture of oxides of manganese, **phosphorus**, and an alkali metal, optionally, supported on a refractory oxide. Notably, the language of "consisting essentially of" specifically excludes unspecified additional components or steps.

In one embodiment of Eastman et al., ethane is converted to ethylene in the presence of a catalyst comprising a mixture of oxides of manganese, **phosphorus**, and sodium supported on alumina. See Eastman at Abstract. Every single catalyst of Eastman et al. contains phosphorus. Clearly, Eastman et al. fails to teach the class of catalysts that do not contain phosphorous. As the court stated in Rowe v. Dror, a negative pregnant cannot be the basis for an anticipatory reference. 42 USPQ2d at 1561. Accordingly, one of ordinary skill in the art would not be enabled to make and use the claimed invention based on the disclosure of Eastman et al. Furthermore, any attempt to incorporate outside references into a 102(b) anticipation rejection to show what would have been well

known in the art is improper. The Examiner is prohibited from using an outside reference to teach a claim limitation not taught by the cited reference.

Accordingly, Applicants respectfully submit that the presently claimed invention is not anticipated by Eastman et al. and respectfully request the Examiner to reconsider and withdraw the 102(b) rejection.

2. Rejection of Claim 8
under 35 U.S.C. § 103(a)

The Office Action rejects claim 8 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,370,259 ("Eastman et al."). The Office Action states:

Eastman discloses a process as discussed above.

Eastman does not disclose a specific catalyst as called for in claim 8 (see the entire patent for details). However, the Eastman catalyst is expected to be very similar to one of the claimed catalyst, namely $Mn_1Sb_{0.15}Na_{0.1}O_x$ since the Eastman's catalyst contains Mn, Na, and phosphorus which is also group V element as antimony (see the periodic table).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Eastman process by using a catalyst containing

antimony in the place of phosphorus since it is expected that using elements in the same group in the periodic table would yield similar results.

Applicants respectfully traverse the rejection of claim 8 over Eastman et al. because each and every claimed limitation is not taught. In particular, Eastman et al. requires the presence of phosphorous, which is no longer claimed by independent claim 1. Although the Eastman et al. catalyst contains phosphorous (a group V element like antimony (Sb)) Applicants note that the empirical nature of catalysts impart patentability upon the presently claimed catalysts over those taught by Eastman et al. In particular, the amount ratios of the various components are critical to the invention. This critical difference can be seen in the difference between the amount ratios of the presently claimed invention and those of Eastman et al. Furthermore, the presently claimed catalysts unexpectedly have a reaction temperature significantly lower than known catalysts.

Turning to the rule, the Federal Circuit held that a *prima facie* case of obviousness must establish: (1) some suggestion or motivation to modify the references; (2) a reasonable expectation of success; and (3) that the prior art references teach or suggest all claim limitations. Amgen, Inc. v. Chugai Pharm. Co., 18 USPQ2d 1016, 1023 (Fed. Cir. 1991); In re Fine, 5 USPQ2d 1596, 1598 (Fed.

Cir. 1988); In re Wilson, 165 USPQ 494, 496 (C.C.P.A. 1970).

However, even if a *prima facie* case of obviousness has been established, secondary considerations such as commercial success, long felt but unsolved need, failure of others, and unexpected results may nevertheless give rise to a patentable invention. Graham v. John Deere Co., 148 U.S.P.Q. 459 (1966). For example, evidence such as superiority in a property the compound shares with the prior art can rebut a *prima facie* case of obviousness. See In re Chupp, 816 F.2d 643, 646, 2 USPQ2d 1437, 1439 (Fed. Cir. 1987).

In the present application, independent claim 1 recites a multimetal mixed oxide having the formula



where Mn denotes manganese;

O denotes oxygen; and

E¹ represents one or more metal elements selected from the group consisting of arsenic, antimony, selenium, tellurium, fluorine, chlorine, bromine, iodine, niobium, tantalum, tungsten, rhenium and copper.

Notably, phosphorous has been deleted from the recitation of E¹.

Dependent claim 8 recites specific embodiments of the catalysts of claim 1 wherein it is alleged that specific variants, particularly those that contain Sb are obvious over the catalysts of Eastman et al. However, Applicants note that the teachings of

Eastman et al. are specifically limited to Mn-P-alkali metal-type catalysts. In particular, Eastman et al. solely relates to catalysts consisting essentially of a mixture of oxides of manganese, **phosphorus**, and an alkali metal, optionally, supported on a refractory oxide. See Eastman at Abstract. Since the language of "consisting essentially of" specifically excludes unspecified additional components or steps, one of ordinary skill in the art would not have expected that any component of the catalyst could be substituted by another member of the same periodic group.

Furthermore, it is noted that the empirical nature of the various components of the catalyst composition is not mere optimization of results effective variables. One of ordinary skill in the art would not have known the specific amount ratios in order to produce an operable catalyst. For example, Eastman et al. teaches a catalyst composition consisting essentially of a mixture of oxides of (a)manganese, (b) phosphorus, and (c) an alkali metal wherein the atomic ratio of (a):(b):(c) is 1:0.03 to 0.25:0.06 to 0.30. Although the alleged specie of catalyst $\text{Mn}_1\text{Sb}_{0.15}\text{Na}_{0.1}\text{O}_x$ is similar to the catalysts of Eastman et al. and while the ratios may fall within the broad ranges taught by Eastman et al., the difference lies in the use of phosphorous versus antimony. It is never clear that simply because the components share the same

periodic group that they can be expected to perform in the same manner upon substitution. If such a substitution was obvious, it would have been taught and claimed by Eastman et al.

Furthermore, the presently claimed catalysts allow for the use of lower temperatures. As noted in Table 1 on page 19 of the specification, the reaction temperatures of the presently claimed catalysts range from 450 to 530° C. In contrast, the reaction temperatures of the catalysts of Eastman et al. range from 650° to 700° C. As stated in the specification at page 1, line 24-25, the prior art catalysts suffer from the disadvantage of being practiced at high temperatures resulting in frequent regeneration. On the other hand, the presently claimed catalysts can operate at significantly lower temperatures thereby imparting significant advantages over known catalysts.

As the court stated in In re Corkill, "a greater than expected result is an evidentiary factor pertinent to the legal conclusion of [non]obviousness". 711 F.2d 1496, 266 USPQ 1005 (Fed. Cir. 1985). One of ordinary skill in the art would not have been motivated to substitute different members within the same periodic group based on the teachings of Eastman et al. to arrive at a catalyst operating at lower reaction temperatures. Clearly, the unexpected and superior advantages of the claimed invention rebuts any allegation of *prima facie* obviousness.

Accordingly, Applicants respectfully submit that claim 8 is unobvious over Eastman et al. and respectfully request reconsideration and withdrawal of the rejections of claim 8 under 35 U.S.C. § 103.

3. Rejection of Claims 3 and 4
under 35 U.S.C. § 103(a)

The Office Action rejects claims 3 and 4 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,370,259 ("Eastman et al.") in view of U.S. Patent No. 3,937,746 ("Croce et al."). The Office Action states:

Eastman discloses a process as discussed above.

Eastman does not disclose that the catalyst also contains sulfur (see the entire patent for details). However, Croce discloses an oxidative dehydrogenation catalyst containing sulfur as promoter (the abstract; col. 2, lines 56-61).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the Eastman process by employing sulfur as a component of the catalyst to improve the catalyst as taught by Croce (col. 2, lines 38-41).

Applicants respectfully traverse the rejection of claims 3 and

4 over Eastman et al. in view of Croce et al. because each and every claimed limitation is not taught. In particular, Eastman et al. requires the presence of phosphorous, which is no longer claimed by independent claim 1. Moreover, Croce et al. requires the presence of Fe-type catalysts to which S has been added as a promoter. However, as noted in the Remarks section, independent claim 1 has been amended to delete "phosphorous", "boron" and "sulfur" from the definition of E¹ and to delete "iron" from the definition of E².

However, since claims 3 and 4 have been deleted without disclaimer or prejudice as to the subject matter contained therein, Applicants respectfully submit that the rejection is now moot and respectfully request withdrawal of the rejection of claims 3 and 4 under 35 U.S.C. § 103.

CONCLUSION


In light of the foregoing, Applicants submit that the application is now in condition for allowance. The Examiner is therefore respectfully requested to reconsider and withdraw the rejection of the pending claims and allow the pending claims. Favorable action with an early allowance of the claims pending is

earnestly solicited.

Respectfully submitted,

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Attorney Docket No. S-2446.01
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:) Group Art Unit: 1764
KISHIMOTO; MATSUNAMI) Examiner: Thuan D. Dang
Serial No. 09/895,416)
Filed: July 02, 2001)
For: **LOWER ALKANE OXIDATIVE DEHYDROGENATION CATALYSTS
AND A PROCESS FOR PRODUCING OLEFINS**

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APPENDIX A

Please amend the claims as indicated according to the revision to 37 C.F.R. § 1.121 concerning a manner for making claims amendments.

Claim 1. (currently amended) In a process for producing an olefin by the vapor phase oxidative dehydrogenation of alkane having from 2 to 5 carbon atoms in the presence of molecular oxygen, the improvement comprising, carrying out the vapor phase oxidative dehydrogenation in the presence of an oxidative dehydrogenation catalyst comprising a multimetal mixed oxide having the formula



where Mn denotes manganese;

O denotes oxygen;

E¹ represents one or more metal elements selected from

the group consisting of ~~phosphorus~~, arsenic, antimony, ~~boron~~, ~~sulfur~~, selenium, tellurium, fluorine, chlorine, bromine, iodine, niobium, tantalum, tungsten, rhenium and copper;

E^2 represents one or more metal elements selected from the group consisting of chromium, ~~iron~~, cobalt, nickel, silver, gold, zinc, thallium, tin, lead, bismuth, lithium, sodium, potassium, rubidium, cesium, magnesium, calcium, strontium, barium, yttrium, lanthanum, cerium, neodymium, and samarium; and,

α , β , γ and x denote atomic numbers of Mn, E^1 , E^2 , and oxygen, respectively, and,

when $\alpha = 1$, $\beta = 0.01-10$, $\gamma = 0-5$, and x has a numerical value determined by the state of oxidation of the elements other than oxygen.

Claim 2. (original) The process according to claim 1, wherein, in the oxidative dehydrogenation catalyst of formula (1), when $\alpha = 1$, $\beta = 0.02-2$ and $\gamma = 0-1$.

Claim 3. (cancelled)

Claim 4. (cancelled)

Claim 5. (original) The process according to claim 1, wherein the oxidative dehydrogenation catalyst of formula (1) is one which is dried and fired at temperatures not higher than 300°C.

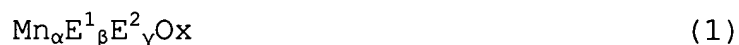
Claim 6. (original) The process according to claim 1, wherein the oxidative dehydrogenation catalyst is supported on a refractory inorganic carrier.

Claim 7. (original) The process according to claim 1, wherein the oxidative dehydrogenation of said alkane is carried out at a space velocity of from 300 to 30,000 hr⁻¹, and at a temperature of from 250 to 650°C.

Claim 8. (currently amended) The process according to claim 1, wherein the oxidative dehydrogenation catalyst is selected from the group consisting of

Mn₁Sb_{0.15}O_x, Mn₁Sb_{0.25}O_x, Mn₁B_{0.1}O_x, ~~Mn₁S_{0.1}O_x~~ Mn₁Nb_{0.05}O_x, Mn₁W_{0.05}O_x,
Mn₁Re_{0.05}O_x, Mn₁Cu_{0.1}O_x, Mn₁Cl_{0.4}O_x, Mn₁Sb_{0.15}Cr_{0.1}O_x, Mn₁Sb_{0.15}Na_{0.1}O_x,
Mn₁Sb_{0.15}Mg_{0.1}O_x, Mn₁Sb_{0.15}Ce_{0.1}O_x, ~~Mn₁S_{0.15}Cr_{0.1}O_x~~ Mn₁Cl_{0.4}Sn_{0.1}O_x,
Mn₁Sb_{0.15}W_{0.05}Cr_{0.1}O_x, ~~Mn₁Sb_{0.15}W_{0.05}S_{0.15}Cr_{0.1}O_x~~ and
Mn₁Sb_{0.15}W_{0.05}Nb_{0.05}Cr_{0.1}O_x.

Claim 9. (withdrawn) In a process for producing unsaturated aldehyde and unsaturated acid by the vapor phase oxidative dehydrogenation of C₂ to C₅ alkene in the presence of molecular oxygen, the improvement comprising, carrying out the vapor phase oxidative dehydrogenation in the presence of an oxidative dehydrogenation catalyst comprising a multimetal mixed oxide having the formula



where Mn denotes manganese;

O denotes oxygen;

E¹ represents one or more metal elements selected from the group consisting of phosphorus, arsenic, antimony, boron, sulfur, selenium, tellurium, fluorine, chlorine, bromine, iodine, niobium, tantalum, tungsten, rhenium and copper;

E² represents one or more metal elements selected from the group consisting of chromium, iron, cobalt, nickel, silver, gold, zinc, thallium, tin, lead, bismuth, lithium, sodium, potassium, rubidium, cesium, magnesium, calcium, strontium, barium, yttrium, lanthanum, cerium, neodymium, and samarium; and,

α, β, γ and x denote atomic numbers of Mn, E¹, E², and oxygen, respectively, and,

when α = 1, β = 0.01-10, γ = 0-5, and x has a numerical

value determined by the state of oxidation of the elements other than oxygen.

Claim 10. (withdrawn) The process according to claim 9, wherein, in the oxidative dehydrogenation catalyst of formula (1), when $\alpha = 1$, $\beta = 0.02-2$ and $\gamma = 0-1$.

Claim 11. (withdrawn) The process according to claim 10, wherein E^1 comprises at least sulfur, and the sulfur is added in the form of its sulfate ion (SO_4^{2-}).

Claim 12. (withdrawn) The process according to claim 9, wherein E^1 comprises at least sulfur, and the sulfur is added in the form of its sulfate ion (SO_4^{2-}).

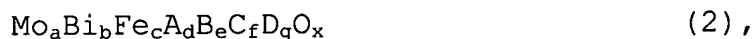
Claim 13. (withdrawn) The process according to claim 9, wherein the oxidative dehydrogenation catalyst of formula (1) is one which is dried and fired at temperatures not higher than 300° .

Claim 14. (withdrawn) The process according to claim 9, wherein the oxidative dehydrogenation catalyst is supported on a

refractory inorganic carrier.

Claim 15. (withdrawn) The process according to claim 9, wherein the oxidative dehydrogenation of said alkene is carried out at a space velocity of from 300 to 30,000 hr⁻¹, and at a temperature of from 250 to 650°C.

Claim 16. (withdrawn) The process according to claim 9, wherein the oxidative dehydrogenation catalyst of formula (1) is a catalyst of the following formula (2):



wherein Mo denotes molybdenum, Bi denotes bismuth, Fe denotes iron, O denotes oxygen,

A represents at least one metal element selected from the group consisting of cobalt and nickel,

B represents at least one metal element selected from the group consisting of alkali metals and thallium,

C represents at least one metal element selected from the group consisting of silicon, aluminum, zirconium and titanium,

D represents at least one metal element selected from the group consisting of tungsten, phosphorus, tellurium, antimony, tin, cerium, lead, niobium, manganese, arsenic and zinc,

a, b, c, d, e, f, g, and x represent the atomic ratios of the respective elements, and, when a=12, b=0.1-10, c=0.1-20, d=2-20, e=0.001-10, f=0-30, g=0-4, and x is a numerical value determined by the state of oxidation of the elements other than oxygen.

Claim 17. (withdrawn) In a process for producing unsaturated acid having from 2 to 5 carbon atoms, by the vapor phase oxidative dehydrogenation of the corresponding unsaturated aldehyde of from 2 to 5 carbon atoms, in the presence of molecular oxygen, the improvement comprising, carrying out the vapor phase oxidative dehydrogenation in the presence of an oxidative dehydrogenation catalyst comprising a multimetal mixed oxide having the formula



where Mn denotes manganese;

O denotes oxygen;

E¹ represents one or more metal elements selected from the group consisting of phosphorus, arsenic, antimony, boron, sulfur, selenium, tellurium, fluorine, chlorine, bromine, iodine, niobium, tantalum, tungsten, rhenium and copper;

E² represents one or more metal elements selected from the

group consisting of chromium, iron, cobalt, nickel, silver, gold, zinc, thallium, tin, lead, bismuth, lithium, sodium, potassium, rubidium, cesium, magnesium, calcium, strontium, barium yttrium, lanthanum, cerium, neodymium, and samarium; and,

α, β, γ and x denote atomic numbers of Mn, E^1 , E^2 , and oxygen, respectively, and,

when $\alpha=1$, $\beta=0.01-10$, $\gamma=0-5$, and x has a numerical value determined by the state of oxidation of the elements other than oxygen.

Claim 18. (withdrawn) The process according to claim 17, wherein the oxidative dehydrogenation catalyst is represented by the following formula (3):



where Mo denotes molybdenum, V denotes vanadium, W denotes tungsten, O denotes oxygen,

E represents at least one element selected from the group consisting of copper, cobalt, bismuth and iron,

F represents at least one element selected from the group consisting of antimony and niobium,

G represents at least one element selected from the group consisting of silicon, aluminum, zirconium, and titanium,

H represents at least one element selected from the group consisting of alkaline earth metals, thallium, phosphorus, tellurium, tin, cerium, lead, manganese and zinc;

h, i, j, k, l, m, n, and x represent the atomic ratios of the respective elements, and, when h=12, i=0.1-10, j=0-10, k=0.1-20, l=0-10, m=0-10, n=0-30, and x has a numerical value determined by the state of oxidation of the elements other than oxygen.

Claim 19. (withdrawn) A process for producing unsaturated acid by the vapor phase oxidative dehydrogenation of C₂ to C₅ alkene in the presence of molecular oxygen, which comprises, oxidatively dehydrogenating lower alkene of from 2 to 5 carbon atoms in the vapor phase in the presence of oxidative dehydrogenation catalyst comprising a multimetal mixed oxide having the formula



where Mn denotes manganese;

O denotes oxygen;

E¹ represents one or more metal elements selected from the group consisting of phosphorus, arsenic, antimony, boron, sulfur, selenium, tellurium, fluorine, chlorine, bromine, iodine,

niobium, tantalum, tungsten, rhenium and copper;

E^2 represents one or more metal elements selected from the group consisting of chromium, iron, cobalt, nickel, silver, gold, zinc, thallium, tin, lead, bismuth, lithium, sodium, potassium, rubidium, cesium, magnesium, calcium, strontium, barium, yttrium, lanthanum, cerium, neodymium, and samarium; and

α, β, γ and x denote atomic numbers of Mn, E^1 , E^2 , and oxygen, respectively, and,

when $\alpha=1$, $\beta=0.01-10$, $\gamma=0-5$, and x has a numerical value determined by the state of oxidation of the elements other than oxygen, to produce a mixture of unsaturated aldehyde and unsaturated acid, and

subjecting the unsaturated aldehyde to further vapor phase oxidative dehydrogenation in the presence of oxidative dehydrogenation catalyst of formula (1) to produce the corresponding unsaturated acid.

Claim 20. (withdrawn) The process according to claim 19, wherein the oxidative dehydrogenation catalyst used in the oxidative dehydrogenation of said unsaturated aldehyde is represented by the following formula (3):



where Mo denotes molybdenum, V denotes vanadium, W denotes tungsten, O denotes oxygen,

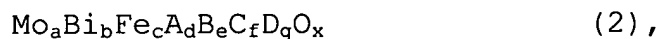
E represents at least one element selected from the group consisting of antimony and niobium,

G represents at least one element selected from the group consisting of silicon, aluminum, zirconium, and titanium,

H represents at least one element selected from the group consisting of alkaline earth metals, thallium, phosphorus, tellurium, tin, cerium, lead, manganese and zinc;

h, i, j, k, l, m, n, and x represent the atomic ratio of the respective elements, and, when $h=12$, $i=0.1-10$, $j=0-10$, $k=0.1-20$, $l=0-10$, $m=0-10$, $n=0-30$, and x has a numerical value determined by the state of oxidation of the elements other than oxygen.

Claim 21. (withdrawn) The process according to claim 20, wherein the oxidative dehydrogenation catalyst used for the oxidative dehydrogenation of said alkene to produce said mixture is a catalyst of the following formula (2):



wherein Mo denotes molybdenum, Bi denotes bismuth, Fe denotes iron, O denotes oxygen,

A represents at least one metal element selected from the

group consisting of cobalt and nickel,

B represents at least one metal element selected from the group consisting of alkali metals and thallium,

C represents at least one metal element selected from the group consisting of silicon, aluminum, zirconium and titanium,

D represents at least one metal element selected from the group consisting of tungsten, phosphorus, tellurium, antimony, tin, cerium, lead, niobium, manganese, arsenic and zinc,

a, b, c, d, e, f, g, and x represent the atomic ratios of the respective elements, and, when $a=12$, $b=0.1-10$, $c=0.1-20$, $d=2-20$, $e=0.001-10$, $f=0-30$, $g=0-4$, and x is a numerical value determined by the state of oxidation of the elements other than oxygen.